APPENDIX 2

BUILDING OUT THE INTERNET

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FIGURES AND TABLES

BUILDING OUT THE INTERNET

Every day people "surf the Internet" without contemplating what the Internet is, where it came from, who is using it, or what will become of it in the future. While it is unnecessary for the typical user to know all the details of the technical operation of the Internet, an understanding of the structure and origins of the Internet provides a basis for understanding the issues and constraints that we face as a larger share of our day-to-day activities moves online.

This section provides a brief, non-technical overview of the Internet that describes:

- The Internet's origins as a tool for government and academic researchers to link to remote supercomputers and communicate with one another, and its subsequent expansion as new technologies made it easier for non-technical people to use.

- The global reach of the Internet and its rapid growth in terms of the number of computers connected to it and the number of people using it.

- The rise of commercial activity on the Internet.

- Steps being taken in the United States to ensure more widespread access to the Internet.

- Potential constraints to commercial activity on the Internet such as security, privacy, reliability, and the development of a predictable tax and legal environment for electronic transactions.

- Issues posed by bandwidth constraints and the technological advances that may ease these constraints.

THE INTERNET: AN OVERVIEW

Today's Internet is based on a commercial system of network backbones (high-speed data lines) that originated in U.S. Defense Department research during the 1960s. The Defense Advanced Research Projects Agency (DARPA) sought communications technologies that would enable undisrupted communications even if major switching centers were incapacitated. This effort led to research into packet-switching technologies that, in turn, led to the 1977 development of two packet-switching protocols—the Transmission Control Protocol (TCP) and the Internet Protocol (IP)—that are fundamental to the operation of the Internet.

Packet-switching differs from circuit switching, the technology used for conventional telephone service. A circuit-switched system opens a direct circuit from the message's origin to its destination. For example, a person making a phone call from San Francisco to New York City gets a unique connection across the network for the duration of the call.

In a packet-switched system, however, a message is broken into chunks or "packets." Each packet is individually addressed and routed across the network to its destination where the message is reassembled. Packets that do not arrive at their destination are automatically retransmitted. Packet-switching is conceptually similar to the way the postal service works. That is, each letter or postcard is individually addressed and moves geographically from point to point as it travels towards its destination. Two postcards mailed from a post office in San Francisco may take different routes to New York City, but once they arrive at the New York City post office they are assembled with the other mail going to the destination address and delivered. Each packet is like a postcard (except that a packet is only part of a message and a postcard is typically a complete message) and network routers are like the mail stops along the way.[1] In a packet-switched system, packets are routed in transit and thus can be routed around congestion or failures in the infrastructure.

Another key step in the evolution of the Internet was the establishment in 1986 of several national supercomputer centers by the National Science Foundation (NSF). The NSF funded a network to link the supercomputer sites and offered to let regional and university computer networks link to this backbone. In addition to using the network to remotely access the NSF supercomputers, the research community developed applications, such as electronic mail, file transfer protocols, and news groups, to facilitate information sharing with colleagues.[2] The linking of university networks to the NSF backbone network, initially to gain remote access to the supercomputer sites, was the genesis of today's Internet.

Network traffic grew as the Internet expanded and evolved, but it was not until the development of the World Wide Web and the advent of graphical Web browsers that the Internet began to generate broad interest outside the academic and government research communities. The World

Wide Web protocols for transferring hypertext (a protocol for creating dynamic links within or between documents) via the Internet were first used in experimental form in 1989 at the European Center for Particle Research in Switzerland.[3] In the early 1990s, the National Center for Supercomputing Applications at the University of Illinois used these protocols to develop a graphical point-and-click interface called Mosaic. Mosaic, the first of the Web browsers, made the Internet easier for non-technical people to use. In the wake of these developments, the Internet began a phase of rapid expansion that continues to this day.

Internet Growth

The Internet is international in scope. While the United States has the most extensive Internet infrastructure, almost every country has some connectivity. The level of connectivity varies by country—ranging from e-mail only to full Internet access. The United States has the highest number of Internet hosts, although Finland, Iceland, and Denmark have higher numbers of Internet hosts on a per capita basis.[4] English is the dominant language of the Internet and is used for approximately 82 percent of Web pages worldwide.[5]

Two commonly used measures of the growth of the Internet are the number of hosts and domains on the Internet. A host is a computer that is connected to the Internet that has a unique Internet Protocol (IP) address.[6] A domain name represents a record within the Domain Name System, such as whitehouse.gov. A top-level domain refers to the final section of an Internet address—com, gov, net, org, and so forth.

The number and growth of Internet hosts and domains give us a rough estimate of the minimum size of the Internet and the rate at which it is expanding.[7] The number of Internet hosts increased from 1.3 million in January 1993 to 19.5 million in July 1997. Over the same period, the number of domains—names registered within the Domain Name System—increased from 21,000 to 1.3 million (Table 1).

Table 1. Hosts and Domains Advertised in the Domain Name System

(thousands)				
	Hosts		Domains	
Date	Number	Growth	Number	Growth
Jul-97	19,540	21%	1,301	57%
Jan-97	16,146	25%	828	70%
Jul-96	12,881	36%	488	103%
Jan-96	9,472	43%	240	100%
Jul-95	6,642	37%	120	69%
Jan-95	4,852	51%	71	54%
Jul-94	3,212	45%	46	53%
Jan-94	2,217	25%	30	15%
Jul-93	1,776	35%	26	24%
Jan-93	1,313		21	

Note: Growth rates for July 1995 forward based on non-rounded source data.
Source: *Network Wizards* http://www.nw.com/

The statistics on cumulative registrations for the com, net, and org top-level domains provide additional evidence of this growth. Network Solutions reports that the net cumulative registrations for these three domains increased from 7,100 in December 1992 to 1.5 million in December 1997.[8]

COMMERCIAL ACTIVITY ON THE INTERNET

The number of commercial top-level domains, one indicator of commercial activity, grew from 27,400 to 764,000 between January 1995 and July 1997.[9] The existence of a business Web page, however, does not necessarily mean that the Web page enables commercial transactions. Some sites are simply a brochure for a company that conducts business offline, while others are full-fledged store fronts for companies that exist solely on the Internet. One 1997 survey of large firms in North America, Europe, and Asia found that 98 percent of the companies surveyed had established some commercial presence on the Internet, but only 47 percent allowed interactive communications and only 15 percent engaged in full-scale business over the Internet.[10]

Nonetheless, commercial transactions over the Internet are expanding—at a rate that is too rapid to gauge with precision. Forrester Research, for example, estimated business-to-business transactions would grow from $7.8 billion in 1997 to $326.4 billion in 2002.[11] At the close of 1997, however, a single company, Cisco Systems, was already reporting a run rate of $3.2 billion in network equipment sales from its Web site.* Early reports of 1997 year-end retail sales online also suggested strong growth.

Many companies are also taking advantage of Internet protocols to create Internet-like networks for company-only use (intranets) or for use by the company and its business partners (extranets). Intranets and extranets connected to the public Internet typically are protected from unauthorized access by security programs known as firewalls.

Text Box 1. Examples of Infrastructure Technologies

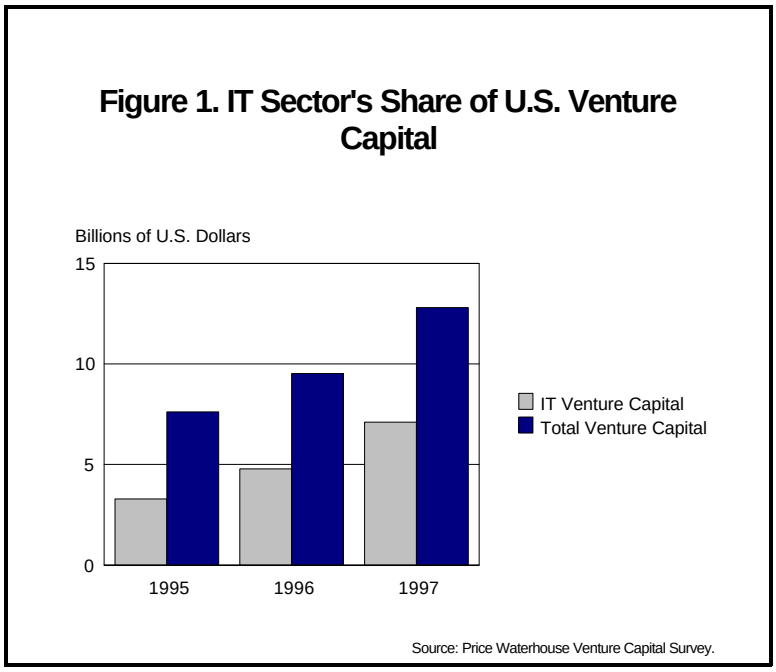
Hardware: Semiconductors (microprocessors, microcontrollers, memory and specialized logic chips), storage devices (disc drives, tape drives, cd roms), batteries, display technologies (cathode-ray tubes, liquid crystal displays), transmission media (coaxial cable, twisted pair copper wire, fiber optic cables, switches, routers, antennas, satellites) remote access devices (modems, cable modems, wireless modems).

Software: Operating systems (desktop, mobile, server), Web browsers, search engines, security software (authentication, authorization, encryption, firewalls), system management software, languages and software development tools, middleware (transport stacks, network operating systems), database management systems, groupware software, workflow software.

Services: Online and Internet access provision, wireless, wireline and satellite service provision, message transport (value added networks), Web site development.

* The run rate is the annual rate of sales based on sales in a single month; in this case December 1997.

The development and expansion of the Internet and Internet-like networking infrastructures that make electronic commerce possible are the result of new developments and the converging technologies from a number of hardware, software, and services industries. Private forecasters, such as Forrester Research, Zona Research, and International Data Corporation predict rapid growth in revenue generated by these industries.



The amount of venture capital funds pouring into business sectors associated with electronic commerce provides additional evidence that investors anticipate continued growth in these industries. The share of venture capital going to the information technology sectors—Software & Information, Communications, Computer & Peripherals, Electronics & Instrumentation, and Semiconductors/Equipment industries—has increased as a share of overall U.S. venture capital (Figure 1). In 1995, these categories represented $3.3 billion (44.2 percent) of a total of $7.6 billion in U.S. venture capital. In 1997, they accounted for $7.1 billion (55.8 percent) of $12.8 billion in U.S. venture capital.[12]

Constraints on Commercial Use

Individuals and businesses cite a number concerns about using the Internet for commercial purposes. Businesses have raised three potential inhibitors to the widespread adoption of Internet commerce: (1) the lack of a predictable legal environment; (2) concerns that governments will overtax, overregulate, or censor the Internet; and (3) uncertainty about the Internet's performance, reliability and security. Consumers cite concerns about security of transactions and the privacy of electronic information.

Businesses

To feel comfortable about using the Internet in communications with its suppliers and customers, a business needs to be sure of the identity of the party at the other end of the transaction and that any agreement made electronically is legally binding. The U.S. Federal government supports the development of both a domestic and global uniform commercial legal framework that will recognize, facilitate, and enforce electronic transactions worldwide. Internationally, the U.S. Federal government is working with the United Nations Commission on International Trade Law. This group has completed work on a model law that supports the commercial use of international contracts in electronic commerce. The Federal government is also working with the International Chamber of Commerce, which has issued model commercial code guidelines.

Companies also typically transmit confidential information on a regular basis, and they want assurance that these transmissions will remain secure. Today, a business verifies identities with passwords, electronic signatures, and Internet Protocol (IP) addresses. Discussions are underway to develop greater security on the Internet. Topics under discussion include encryption, digital signatures, and digital certificates.

> Encryption—A technology that encodes a message before it is sent and decodes it when it is received. Encryption used to protect a message from unauthorized viewing and alteration.
>
> Digital Signatures—An electronic version of a signature. One of a number of signature alternative technologies, it uses cryptographic techniques to verify that the person who sent the message in fact sent the message and that the contents have not been altered since the message was sent.
>
> Digital Certificates—An electronic third party "voucher" that a message is authentic. This is conceptually similar to paper-based certificates, such as birth certificates, passports, and drivers licences. The certificate (e.g., a driver's license) issued by a credible third party (state government) indicates that the information carried in the message (name, address, etc.) is authentic.

Companies are also concerned about the potential for excessive taxation of the Internet. The U.S. Federal government believes that no new discriminatory taxes should be imposed on Internet commerce. It also believes that no customs duties should be imposed on electronic transmissions. The application of existing taxation on commerce conducted over the Internet should be consistent with the established principles of international taxation, should be neutral with respect to other forms of commerce, should avoid inconsistent national tax jurisdictions and double taxation, and should be simple to administer and easy to understand.

Companies are also concerned that government may over-regulate or censor the Internet, passing cumbersome regulations that limit content or make too complex or unpredictable the ways that

buyers and sellers can conduct business. The U.S. government supports the development of the Internet as a market-driven arena, not a regulated one. This means that governments should refrain from passing regulations to govern the Internet. Where possible, rules for Internet behavior should be set through private collective action rather than government regulation. The aim of these rules should be to empower consumers to protect their own privacy, control the content they see, and protect themselves against inappropriate commercial behavior. Competition and consumer choice should be the guiding principles of Internet commerce.

Some companies are concerned about the Internet's performance and reliability. Businesses that have conducted Electronic Data Interchange transactions over private value added networks know through experience that important information will likely arrive at its destination, on schedule, and intact. If problems arise, a single network service provider is accountable and responsible for resolving them. The Internet offers no such guarantees. As a public network of interconnected networks and service providers, there is no single entity responsible for ensuring that a message leaves one point and arrives, intact, at another.

Consumers

Most Internet purchases are currently made by entering credit card and delivery information on a computerized form and transmitting it electronically to the retailer. Even though consumers are accustomed to giving credit card information over the telephone, many are reluctant to give it online for fear that it will be stolen or misused. This reluctance is often cited as the largest barrier to the growth of Internet retail trade. Web retailers suggest that this difficulty may be largely a matter of perception and that over time concerns about credit card security will decline as more people shop online.

The privacy of information provided by Web users or recorded as a user moves around the web is also a key concern of individuals contemplating using the Internet for commercial and non-commercial purposes. A majority of respondents to a recent *Business Week/Harris* poll reported privacy as the main reason they do not use the Internet. More than three-quarters of current users say they would use the Web more if privacy were guaranteed.[13]

A remote transaction, such as an online purchase, requires the provision of some information—for example, the name and address of the purchaser. A purchase made online may trigger the creation of a customer profile in a Web merchant’s database. Collecting data on a customer’s past purchases enables a company to personalize service, by informing a customer of the release of a new book by a favorite author, for example. Some Web sites request that visitors provide personal information upon entering the site. In exchange for that information, they may offer "membership" services such as new product announcements or newsletters. An Internet user may also unwittingly leave an electronic "footprint" of visits to different Web sites. In any of these cases, the consumer may have little control over how this information is compiled or distributed.

The U.S. Federal government is encouraging the private sector to establish codes of conduct and self-regulation. It maintains that effective self-regulation involves substantive rules, as well as the means to ensure that consumers know the rules, that companies comply with them, and that consumers have appropriate recourse when injuries result from noncompliance. Consumers need to know the identity of the collector of their personal information, the intended uses of the information, and the means by which they may limit its disclosure. They should be given the opportunity to exercise choice with respect to whether and how their personal information is used. Companies creating, maintaining, using, or disseminating records of identifiable personal information must take reasonable measures to ensure its intended use and must take reasonable precautions to protect it from loss, misuse, alteration, or destruction. In addition, a consumer should have the opportunity to access, in a reasonable and appropriate manner, personal information that has been compiled by a company, and should be able to correct or amend that information when necessary.

GROWTH OF INTERNET USAGE

Internet usage is difficult to measure. A person may have access to the Internet, but not use it, or have full access but only use basic applications like e-mail. A person may have multiple Internet accounts—for example at home and at work or school. Alternatively, a user may not have an account at all and instead use the Internet at a library or a cyber café.

Due to the rapid growth of Internet usage, estimates of the number of people online in the United States and worldwide are released regularly.[14] Estimates ranged from 51 million to 62 million people online in the United States, to as many as 101 million people online worldwide in 1997.[15] While absolute numbers may vary by source, few analysts disagree that Internet usage is growing rapidly.

A 1997 CommerceNet/Nielsen study of Internet users in the United States and Canada suggests that recent Web users are younger, more highly educated, and have higher household incomes than the population as a whole.[16]

- 48.0 percent have an associate college degree or a higher level of education, compared to 28.3 percent in the population as a whole.

- The average age of recent Web users is 34.5 years, compared to 43.5 years for the population as a whole.

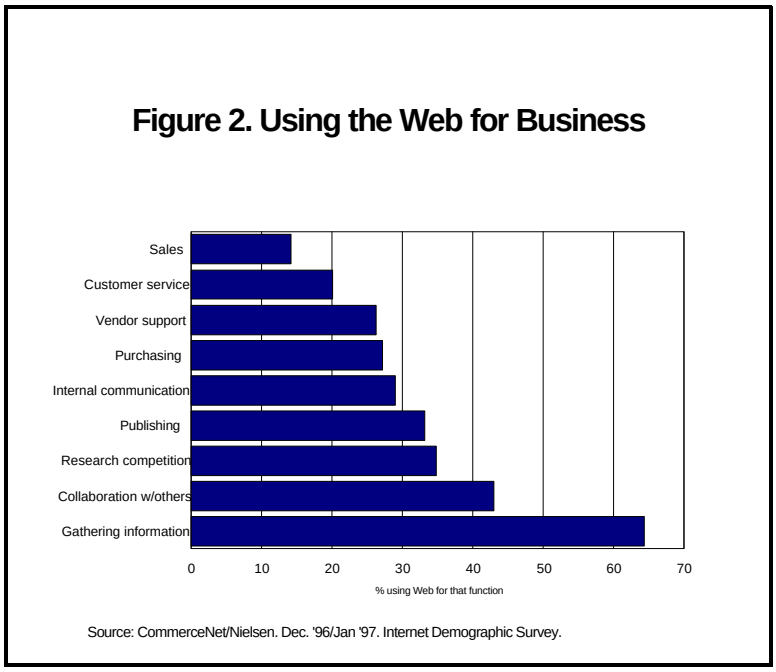
- 33.9 percent have household incomes of $60,000 or more, compared to 19.5 percent for the population as a whole.

Recent World Wide Web users use the Web for a variety of purposes:

- 53.1 percent use it for personal reasons, 23.2 percent for work, and 22.3 percent for school.

- 33.4 percent have used the Web for business purposes, with business activities ranging from gathering product and service information to selling products and services (Figure 2).

A more recent survey conducted during Fall 1997 indicates that use of the Web for business purposes had increased in essentially all of the categories shown in Figure 2. Furthermore, by Fall 1997, 10.1 million people (16.1 percent of recent Web users) had made purchases online up from 7.4 million six months earlier.[17]



Access For Everyone—Universal Service

The demographic statistics point to one of the challenges of the new era of communications—making sure that all segments of the population have the opportunity to use these new technologies.

The United States has a long history of supporting "Universal Service" in telecommunications. The concept in general terms was written into Section 1 of the 1934 Communications Act:

... to make available, so far as possible, to all the people of the United States a rapid, efficient, Nationwide, and worldwide wire and radio communication service with adequate facilities at reasonable charges ...[18]

The extension of the universal service concept to ensure that information resources are available to all at affordable prices was a key goal of the *1993 National Information Infrastructure: Agenda for Action*.[19]

The 1996 Telecommunications Act provided the legal framework under which the expansion of the universal service concept became possible.[20] The new framework created opportunities for greater investment in high technology communications, networking, and Internet access at schools, public libraries, and hospitals, particularly in poor and rural areas.[21] The structure for this expanded universal service was established in May 1997 via the Federal Communication Commission's Universal Service Order. Beginning January 1, 1998, up to $2.25 billion annually will be available to provide eligible schools and libraries with discounts, ranging from 20 percent to 90 percent, for all telecommunications services, Internet access, and internal connections. The level of these "E-Rate" discounts will be correlated to indicators of poverty and high cost for schools and libraries.[22] Universal service provisions will also provide support for public and not-for-profit health care providers who do not have access to the Internet on a local dial-up basis and who presently have to pay to charges to reach the Internet.

While there is still much more to be done to ensure widespread access to the Internet and other advanced technologies, important first steps have been taken. For example, programs such as the Telecommunications and Information Infrastructure Assistance Program at the Department of Commerce have been established to facilitate the creation of public-private partnerships to bring

advanced communications technologies to communities throughout the United States. Federal grant money from this program, combined with private funds and volunteer work by people at the grass roots level, has already brought advanced technologies to schools, police stations, and community centers that might otherwise have been left behind.[23]

ACCESSING THE INTERNET

A connection to the Internet requires an Internet-enabled device and a communications link to the Internet. Together, they play a critical role in determining which electronic commerce goods and services a person can access. Various companies are bringing new Internet-enabled appliances to the market, giving consumers a broad range of options for connecting to the Internet. These technologies may compete directly with the PC as the main household Internet access device and include network computers or Internet television, or access may be bundled into other communications devices, such as telephones, pagers, or handheld computers. At the same time, technology options enabling faster connections to the Internet for residential users are expanding and becoming more widely available.

THE COMMUNICATIONS LINK—THE IMPORTANCE OF BANDWIDTH

The delivery of e-mail, images, software, or any other electronic product or service depends on the capacity—that is, the bandwidth—of the telecommunications system. Bandwidth, measured in terms of bits per second, determines the speed at which data can flow through the computer and communications systems without interference.[**]

In simple terms, communications networks operate by converting text, images, or sounds into numbers, sending signals representing those numbers across the network, and then converting the signals back into text, sounds, or images. For example, on a digital network, information (text, picture, or sound) is converted into strings of ones and zeros (digitized) and then transmitted across the network via signals (light pulses, electrical current pulses, or radiowave frequency changes) that represent either ones or zeros. The bandwidth of the system is the rate at which the signals can be transmitted without confusing the ones and zeros. As Michael Dertouzos, the Director of the MIT Laboratory for Computer Science, describes it, if we were sending smoke signals, the bandwidth would be the rate at which we could flap our blanket and still be able to distinguish the individual puffs of smoke. If we flap too fast, we end up with a column of smoke that means nothing.[24]

In the early days of the Internet, most messages were simple text that did not require large amounts of bandwidth. However, following the advent of the World Wide Web, the desire to transmit information requiring large amounts of bandwidth—images, sounds, software, streaming video, telephony, and so forth—increased rapidly. A fast/high bandwidth connection can make a

[**] A bit (*b*inary dig*it*) is the smallest indivisible unit of digital information—either a one or a zero. One byte = 8 bits. Kbps = kilobits per second = 1,000 bits per second; mbps = megabits per second = 1,000,000 bits per second; gbps = gigabits per second = 1,000,000,000 bits per second.

vast difference in a person's willingness to access products and services electronically (Table 2). An Internet user probably will not spend 46 minutes waiting for a 3.5-minute video clip (approximately the amount of video represented by a 10 megabyte file) to download, but would wait if it took only a minute or a few seconds to download the same file.[25] Thus, the bandwidth of a consumer's connection to the Internet is a prime determinant of the products and services that can be delivered electronically.

Many businesses already have access to, and resources to afford, high-bandwidth connections through various dedicated services now available from Internet Service Providers and local phone companies. Generally, however, residential users are constrained by low bandwidth connections. Residential users typically access the Internet via a dial-up connection using a 14.4 to 56 kbps analog modem over a normal telephone line. During the fall of 1997, the majority of U.S. users connected at speeds of 28.8 to 33.3 kbps.[26]

The options for high-speed residential Internet access are, however, increasing rapidly (Table 3). Analog modem speeds have increased from a then state-of-the-art speed of 14.4 kbps in 1993 to 56 kbps in 1997. Integrated services digital network (ISDN) technologies, which offer faster access, have become widely available, although without a large increase in penetration for Internet use. In 1997, trials of various Digital Subscriber Line (DSL) technologies were initiated.[27]

Cable TV companies are in the process of upgrading their infrastructures to enable 1.2 to 27 mbps shared capacity Internet access speeds. Options for wireless Internet access from terrestrial and satellite service providers are also increasing—some of them offering high-speed access for residential users.

Table 2. Transfer Speed Comparison for a 10-megabyte File

Modem Speed/Type	Transfer Time
9.6 Kbps modem	2.3 hours
14.4 Kbps modem	1.5 hours
28.8 Kbps modem	46 minutes
128 Kbps ISDN	10 minutes
1.54 Mbps T-1 connection	52 seconds
4 Mbps cable modem	20 seconds
8 Mbps ADSL technology	10 seconds
10 Mbps cable modem	8 seconds

Source: FCC, CS Docket No. 96-496, 1997; ASDL from Werbach 1997, p. 75.

Table 3. Major End-use Internet Access Technologies

Technology	Downstream	Upstream	Penetration	Comments
POTS—"Plain Old Telephone Service" (analog voice telephony)	14.4-56 kbps	14.4-56 kbps	94 percent of homes have POTS services.	Requires no additional telco investment and only a computer and (inexpensive) analog modem at the user premises.
ISDN—Integrated Services Digital Network	56-128 kbps (230 kbps under development)	56-128 kbps (230 kbps under development)	Approximately 70% of access lines are now capable of supporting ISDN, but less than 5% of Internet subscribers use ISDN.	New pricing, standardization, marketing efforts may increase penetration.
xDSL—Digital Subscriber Line	384 kbps (SDSL) 768 kbps (HDSL) 1.5-8 Mbps (ADSL)	384 kbps (SDSL) 768 kbps (HDSL) 1.5-8 Mbps (ADSL)	Significant deployment of SDSL and HDSL today for corporate networks and T1 services.	Commercial ASDL deployment by most telcos planned to begin in 1997.
Cable Modems	1.2-27 Mbps (shared capacity)	128 kbps-10 Mbps (shared capacity) or POTS line used for upstream.	Commercially available in 1997.	Several companies have deployed infrastructure.
Wireless	28.8 kbps (900 Mhz) 1.5 Mbps—Local Multipoint Distribution Service (LMDS) 1.5 Mbps—Multichannel Multipoint Distribution Services (MMDS)	28.8 kbps (900 Mhz) 1.5 Mbps (LMDS) 1.5 Mbps (MMDS)	Some technologies under development that could provide wireless Internet access.	Actual bandwidth will depend on environmental factors as well as details of deployment.
Satellite	400 kbps	POTS line used for upstream		DirectTV® available. Several other systems under development.

Source: Primarily from Werbach, Kevin. "Digital Tornado: The Internet and Telecommunications Policy. Federal Communications Commission, OPP Working Paper Series, # 29. March 1997. p. 75.

Communications carriers have also dramatically increased bandwidth by: (1) increasing capacity (e.g., laying more fiber and cable, launching more satellites); (2) upgrading to a higher bandwidth infrastructure (e.g., replacing cable with fiber, upgrading to faster electronic switches); (3) developing technologies that squeeze more bandwidth out of the existing infrastructure (e.g., asynchronous transfer mode, wave division multiplexing); and (4) developing compression technologies that squeeze data into fewer bytes. For example, new electronics that double the capacity of existing fiber optic lines have been deployed every one to two years. In the late 1970s, a strand of fiber could carry 2 mbps. By 1997, a single strand could carry 10 gbps, a five thousand-fold increase in capacity.[28] According to Lucent Technologies, a single strand of optical fiber today can transmit 400 gigabits per second, enabling carriers to build networks capable of transmitting the equivalent of over 90,000 volumes of an encyclopedia in one second.[29]

Internet Appliances

The Web surfer's options for gaining access to the Internet are also expanding. Currently the primary Internet appliance is the personal computer (PC). While the PC is not likely to disappear as an important Internet appliance in the near future, additional devices will likely supplement it. The two most commonly cited reasons for the limited household penetration of PCs, currently at about 43 percent, is that they are expensive and difficult to use.[30] Not surprisingly, new and proposed Internet appliances, such as Internet TVs and smart phones, are based on familiar consumer electronics that non-technical consumers will likely find less intimidating and easier to use than the PC.

The Internet TV uses a TV as its monitor and a set-top box to connect to the Internet via a telephone line (or potentially a cable TV network connection). These products take advantage of the existing penetration of televisions in U.S. households (98 percent) and the consumer's familiarity with set-top boxes, which are used to unscramble premium cable channels in many of the 66.2 percent of U.S. households with cable television.[31] Internet TV promises full browser capabilities, the ability to download and save information, printing capability, and e-mail (via either an on-screen key board or a wireless keyboard). The first movers in the Internet TV market offered Internet access via a special Internet service provider as a separate TV channel. Next generation offerings promise interactivity that will enable a Web surfer to watch a TV program and simultaneously interact with that program via the Internet connection. Video game consoles are another popular consumer electronics device with potential as an Internet appliance for connecting the TV to the Internet from the home. A number of video game manufacturers, such as Sega Enterprises, Ltd. and Nintendo Co. Ltd., are introducing Web browsing capabilities into their game consoles.[32]

The telephone, another wide-spread and easy-to-use household and mobile appliance, is also becoming a popular medium for Internet access. Cellular and Personal Communications service providers have developed smart phones—wireless telephones capable of browsing the Internet and sending and receiving e-mail messages.[33] Alphanumeric pagers are becoming "information delivery devices" capable of receiving sports scores, stock quotes, news and weather updates, and

e-mail delivered from the Internet.[34] Some Personal Digital Assistants (PDAs), personal organizers, and handheld PCs are also capable of receiving Internet messages, such as e-mail.

The rise of a broad range of Internet appliances does not point to a decline in the use of personal computers. Computer prices continue to fall, reducing the price barrier to the spread of their use. Some now cost less than $1000. At the same time, hardware and software companies have been working to make them easier to use.[35] The emergence of new appliances is just one facet of the complex evolution of the information technology industries. For example, at the same time that Internet TV is offering Internet access, PCs are able to receive TV broadcasts (albeit usually of primitive picture quality due to bandwidth constraints) transmitted over the Internet. Similarly, a PC can be used to make telephone calls over the Internet. Thus, as consumers are being offered new technologies to browse the Internet or access Internet e-mail, the Internet is becoming a new way to access familiar services, such as telephone service or television broadcasts.

Text Box 2. Telecommunications—An Industry in Transition

The large scale changes that are taking place in the telecommunications industry are important to the Internet because the infrastructures are largely intertwined. Internet backbones are typically high-speed communications lines leased from telecommunications companies. Internet traffic travels over virtually all of the interconnected telecommunications networks. Furthermore, many telecommunications companies have expanded to provide Internet access services.

Since the 1980s, telecommunications in the United States have undergone a process of deregulation that has brought increasing competition to the industry. Until the early 1980s, American Telephone & Telegraph (AT&T) served 80 percent of U.S. telephone lines under a regime regulated by U.S. State and Federal governments. In 1982 the U.S. courts acted to break up the AT&T monopoly and in1984 the AT&T divestiture created a system of competitive long distance markets and monopoly local services. This was the beginning of an era of telecommunications deregulation in the United States.

In 1996, Congress passed and President Clinton signed into law sweeping legislation of the communications industries—the Communications Act of 1996. This legislation calls for increased competition among telecommunications companies and contemplates an end to different and separable communications markets defined by regulation instead of competition. The Internet embodies the purpose behind this goal—Internet networks make no distinction between text, images, sounds, or video.

Around the world, other countries have also taken steps to deregulate, privatize, and increase competition in their telecommunications industries. These steps include the recently signed World Trade Organization agreement on basic telecom services, which was agreed to by 72 countries, which will accelerate liberalization and deregulation of basic telecommunications services.

NEXT GENERATION INTERNET

In October 1996, the Clinton administration announced its support for the Next Generation Internet (NGI) Initiative, an initiative to provide funding to academic, government, and industry research communities to advance research into experimental network applications, services, and infrastructure. The Clinton Administration's Fiscal Year 1999 budget allocates $850 million for research and development for the Large Scale Networking and High-end Computing and Computation research and development program. Of this proposed funding, $110 million will go to the NGI Initiative.[36]

The NGI will enable the development of high-performance test networks among research centers to "provide system-scale testing of advanced services and technologies and to support testing of advanced applications."[37] Two NGI goals are to develop a broadly based network that will connect research institutions across the country at end-to-end performance speeds 100 times that of the current Internet and to develop an ultra-high-speed network among a select group of institutions that will function at speeds 1000 times faster than the current Internet.[38]

The NGI initiative will also work in conjunction with networking projects, such as Internet2, a collaborative effort by more than 100 U.S. research universities to create and sustain a leading edge network for developing network engineering and management tools and broadband applications for advanced research and education.[39]

Thus, as in the development of the early networking technologies that foreshadowed the Internet, the next generation of networking technologies will likely stem from study of pre-competitive technologies by the academic, government, and industrial research communities. This research will provide a foundation for a faster, more reliable, and more secure public Internet in the future.

CONCLUSION

During the 1990s the Internet has grown dramatically, both in terms of the number of computers connected to it and the number of people using it. This growth has been so rapid that it is difficult to gauge it with precision; however it is clear that the Internet is becoming an important medium for communicating information and conducting commerce.

Ten million people in the United States and Canada have already used the Web to purchase a good or service online. A great many more use the Web to gather product and service information before making an offline purchase. Many companies use the Internet for procurement, customer service, sales, and other key business processes. Consumers are being offered faster connections and a broader range of devices to connect to the Internet. In addition, new and proposed Internet appliances, such as Internet TVs and smart phones, will likely make the Internet easier and less intimidating for non-technical people to use.

New research has been proposed and is underway in government, academic, and private sector research communities that foreshadows the next generation of networking technologies. This research promises a strong foundation for a faster, more reliable, and more secure public Internet in the future.

ENDNOTES

1. Cerf, Vinton. "The Internet Phenomenon" 1995. National Science Foundation Web Page. http://www.cise.nsf.gov/general/compsci/net/cerf.html

   Richard, Jack. "Internet Architecture." *BoardWatch Magazine*. 1997. http://www.boardwatch.com/isp/archit.htm

2. For much more comprehensive, but still brief, histories of the Internet see the Internet Society Web page at http://www.isoc.org/internet/history/

3. Cerf, Vinton. "The Internet Phenomenon." National Science Foundation Web page. http://www.cise.nsf.gov/general/compsci/net/cerf.html

4. OECD. *Communications Outlook 1997: Volume 1*. Paris: OECD 1997. http://www.oecd.org/

5. Babel (a joint venture from Alis Technologies and the Internet Society). "Web Languages Hit Parade." http://www.isoc.org:8080/palmares.html.

6. Host computer are now able to do "virtual hosting," where one computer hosts multiple domains (i.e., multiple IP addresses).

7. The data on domains and hosts are collected through an automated program that searches the Internet and for hosts and domains and automatically queries them. The measure is a minimum estimate of the Internet size because some hosts do not allow automated transfers of domain information. Furthermore, there is no way of estimating how many hosts and domains are missed in the search process.

   Lotter, M. "Internet Growth (1981-1991)." Network Wizards Web site. 1992. p. 2. http://www.nw.com/zone/rfc1296.txt

   For the January 1998 *Internet Domain Survey*, Network Wizards changed the methodology to address problems related to collecting information about hosts that do not allow automated transfers of domain data. The resulting data, however, are not comparable with the historical series presented in Table 1. In reporting the January 1998 host data, Network Wizards also reported adjusted data from January 1995 to July 1997 by increasing the old survey host count by the percentage of domains that did not respond to the old survey method. The January 1998 data combined with the adjusted host data from previous surveys reveal that the grow of hosts continued through January 1998.

Endnote Table

Date	Survey Host Count	Adjusted Host Count	Growth	
Jan 98	29,670,000		13.9	first NEW Survey
Jul 97	19,540,000	26,053,000	19.4	last OLD Survey
Jan 97	16,146,000	21,819,000	30.4	
Jul 96	12,881,000	16,729,000	16.6	
Jan 96	9,472,000	14,352,000	75.0	
Jul 95	6,642,000	8,200,000	40.2	
Jan 95	4,852,000	5,846,000		

Source: *Network Wizards* http://www.nw.com/

8. Network Solutions, Inc. Private communication received February 1998.

9. Network Wizards. "Internet Domain Survey." http://www.nw.com/

   Com top-level domain provide only a rough measure of Web sites potentially enabled for electronic commerce. As noted in the text, a com domain does not necessarily imply the ability to make transactions. Furthermore, Web pages with non-commercial top-level domains (e.g., org, net, gov) also may enable electronic commerce. For example research organizations may enable the online purchase.

10. "Net Gains in Market Space." Information Strategy Online. July/August 1997. http://www.info-strategy.com/.

    Soumitra, Dutta. Stephen Kwan, and Arie Segev, "Competing in Marketspace: Strategic Marketing and Customer Relationships." Unpublished study. 1997.

11. Forrester Research, Inc. "Sizing Intercompany Commerce: Market Model." July 1997. p.4.

12. Price Waterhouse. "Price Waterhouse National Venture Capital Survey: National Edition Top Line Results Full Year 1995." Price Waterhouse LLP. 1996.

    Price Waterhouse. "Price Waterhouse National Venture Capital Survey: National Edition Top Line Results Full Year 1996." Price Waterhouse LLP. 1997.

    Price Waterhouse. "Price Waterhouse National Venture Capital Survey: National Edition Top Line Results First Quarter 1997." Price Waterhouse LLP. 1997.

    Price Waterhouse. "Price Waterhouse National Venture Capital Survey: National Edition

Top Line Results Second Quarter 1997." Price Waterhouse LLP. 1997.

Price Waterhouse Venture Capital Survey Q3:1997 & Q4:1997. http://www.pw.com/vc

13. Green, Heather. "A Little Net Privacy, Please." *Business Week*, March 16, 1998.

14. One high-tech consulting firm—NUA— tracks surveys and posts comparisons of the estimates on their Web page; see NUA Internet Surveys, "How Many Online?." http://www.nua.ie/surveys/how_many_online/index.html.

15. A Fall 1997 survey by Georgia Tech's Graphic, Visualization, & Usability Center (GVU) found that 84.2 percent of Internet users were from the United States; 6.7 percent were from Europe; 4.6 percent were from Canada; 2.7 percent were from Oceania; 0.8 percent were from Asia; and 0.3 percent were from South America.

    Graphic, Visualization, & Usability Center. 8th WWW User Survey. October/November 1997. http://www.gvu.gatech.edu/user_surveys/survey-1997-10

    CommerceNet Nielsen estimates 51 million recent Web users in the United States and Canada for the 6 months ending January 1997 and 62.8 million people for the six months ending September 1997.

    CommerceNet/Nielsen. "Internet Demographic Study: Dec '96/Jan'97" Volume 1. 1997. The Fall 1997 statistics were provided by a CommerceNet/Nielsen representative.

    IntelliQuest estimates 62 million online in the United States in as 1997 fourth quarter.

    IntelliQuest. "Latest IntelliQuest Survey Reports 62 Million American Adults Access the Internet/Online Services." IntelliQuest Press Release. February 4. 1998. http://www.intelliquest.com/about/release41.htm.

    "How Many on Line?" NUA Web site. Accessed on January 23, 1998. http://www.nua.ie/surveys/how_many_online/index.html.

16. CommerceNet/Nielsen. *Internet Demographic Study*. CommerceNet Nielsen. Vol. 1 & 2. Spring 1997.

17. The Fall 1997 statistics were provided by a CommerceNet/Nielsen representative. See also: CommerceNet. "Electronic Commerce on the Rise According to CommerceNet /Nielsen Media Research Survey " Press Release. December 11, 1997. http://www.commerce.net/news/press/121197.html

18. *P.L. 73-416, June 19, 1934.* http://www.crl.com/~akline/1934act.htm.

    As amended by the Telecommunications Act of 1996, that provision now reads:

    > ...to make available, so far as possible, to all the people of the United States, without discrimination on the basis of race, color, religion, national origin, or sex, a rapid, efficient, Nation-wide, and world-wide

wire and radio communication service with adequate facilities at reasonable charges...

The full text of the amended 1934 Communications Act can be found at http://www.fcc.gov/telecom.html.

19. Information Infrastructure Task Force. *The National Information Infrastructure: Agenda for Action*. Washington D.C.: National Telecommunication and Information Administration-NII Office. September 15, 1993. pp. 7-8.

20. Sections 254, 706, and 708. *Telecommunications Act of 1996, Pub. LA. No. 104-104, 110 Stat. 56 (1996).* http://www.fcc.gov/telecom.html

21. For information regarding the advanced communications technologies in rural and poor areas see:

    National Telecommunication and Information Administration. *Falling Through the Net: a Survey of the "Have Nots" in Rural and Urban America.* Washington D.C.: U.S. Department of Commerce. July 1995. http://www.ntia.doc.gov/ntiahome/fallingthru.html

    For information regarding Internet access in U.S. public elementary and secondary schools see:

    National Center for Education Statistics. “Issue Brief: Internet Access in Public Schools.” Washington, D.C.: U.S. Department of Education. February 1998. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=98031XXXXX.

    National Center for Education Statistics. *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, Fall 1996.* Washington, D.C.: U.S. Department of Education. February 1997.

22. Federal Communications Commission. *Report & Order In the Matter of Federal-State Joint Board on Universal Service.* FCC 97-157, CC Docket No. 96-45. 1997. p. 19. http://www.fcc.gov/ccb/universal_service/fcc97157/97157pdf.html

23. National Telecommunications and Information Administration. *Networks for People: TIIAP at Work.* Washington D.C.: U.S. Department of Commerce. October 1997. http://www.ntia.doc.gov/otiahome/tiiap/index.html.

24. Dertouzos, Michael L. *What Will Be: How the New World of Information Will Change Our Lives.* New York: HarperEdge, 1997. pp. 324-325.

25. Federal Communications Commission (FCC). "Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming.” CS Docket No. 96-496. January 2, 1997. pp. 58-59. http://www.fcc.gov/Bureaus/Cable/Reports/fcc97423.html

26. Graphic, Visualization, & Usability Center. 8th WWW User Survey. October/November 1997. http://www.gvu.gatech.edu/user_surveys/survey-1997-10.

27. DSL technologies modify existing telephone lines to enable voice calls at the same time as high-speed Internet access (384 kbps to 8 mbps depending on technology).

28. Goldman Sachs. "Telecos and Long Distance: Telecom's New World Order."April 11, 1997. p. 3.

29. Lucent Technologies. http://www.lucent.com/netsys

30. IDC/Link cited in Burrows, Peter, Gary McWilliams, and Robert D. Hof. "Cheap PCs: The Model T of the Digital Era." *Business Week*. March 23, 1998. pp. 28-33.

    Historically, the PC has been expensive relative to other consumer electronics. In 1997, however, several manufacturers announced the plans to market complete multimedia PC systems for less than $1000. According to Business Week, by the end of 1997 sub-$1000 PCs accounted for 30 percent of all computers sold through U.S. computer and electronic stores (*Ibid. p. 28)*.

31. U.S. Department of Commerce, U.S. Bureau of the Census. *Statistical Abstract of the United States 1997*. (117th Edition.) Washington, D.C., 1997. p. 566.

    Federal Communications Commission (FCC). "Annual Assessment of the Status of Competition in Markets for the Delivery of Video Programming (Fourth Annual Report) (FCC 97-423) 1998. p.16. http://www.fcc.gov/Bureaus/Cable/Reports/fcc97423.html.

32. Price Waterhouse. *Technology Forecast: 1997*. Menlo Park, California: Price Waterhouse World Technology Centre. 1997. p.182.

33. Consumer Electronics Manufacturers Association (CEMA). "U.S. Consumer Electronics Industry Today." Arlington, Virginia. June 1997. pp. 50-51.

34. Consumer Electronics Manufacturers Association (CEMA). "U.S. Consumer Electronics Industry Today." Arlington, Virginia. June 1997. p. 52.

35. Burrows, Peter, Gary McWilliams, and Robert D. Hof. "Cheap PCs: The Model T of the Digital Era." *Business Week*. March 23, 1998. pp. 28-33.

36. *Budget of the United States Government: Fiscal Year 1999*. U.S. Government Printing Office. 1998. p.102. http://www.access.gpo.gov/su_docs/budget/index.html

37. "Next Generation Internet Initiative: Concept Paper." National Coordination Office for Computing, Information and Communications. July 1997. p. 3. http://www.ccic.gov/ngi/concept-Jul97/.

38. *Ibid.* p.6.

39. For more information see the Internet2 Web site at http://www.internet2.edu/.

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